

Alaska Department of Fish and Game
Division of Wildlife Conservation
December 2001

Factors Limiting Moose at High Densities in Unit 20A

Mark A. Keech
Rodney D. Boertje
Donald D. Young

**Research Performance Report
Federal Aid in Wildlife Restoration**

1 July 2000–30 June 2001
Grant W-27-4, Study 1.51

This is a progress report on continuing research. Information may be refined at a later date.

If using information from this report, please credit the author(s) and the Alaska Department of Fish and Game. The reference may include the following: Keech, M.A., R.D. Boertje and D.D. Young. 2001. Factors limiting moose at high densities in Unit 20A, 1 July 2000–30 June 2001. Alaska Department of Fish and Game. Federal aid in wildlife restoration research performance report, grant W-27-4, study 1.51. Juneau, Alaska. 7 pp.

FEDERAL AID ANNUAL RESEARCH PERFORMANCE REPORT

PROJECT TITLE Factors Limiting Moose at High Densities in Unit 20A

AUTHORS: Mark A Keech, Rodney D Boertje, and Donald D Young

COOPERATORS: C Tom Seaton, Kalin Kellie, Layne Adams (USGS)

GRANT AND SEGMENT NR.: W-27-4

PROJECT NR.: 1.51

SEGMENT PERIOD: 1 July 2000–30 June 2001

STATE: Alaska

WORK LOCATION: Unit 20A

I. PROGRESS ON PROJECT OBJECTIVES

OBJECTIVE 1: Review literature on moose biology, indices of nutritional status, ungulate population models, predator-prey relationships, and harvest data.

We continue to review available scientific literature.

OBJECTIVE 2: Estimate and evaluate the usefulness of several reproductive and condition indices for moose in Unit 20A.

Since 1996 we have observed a parturition rate of 64% ($n = 346$) and a twinning rate of 11% ($n = 221$) for radiocollared moose ≥ 3 years old. Strong age-specific indicators of nutritional stress were even more noteworthy: 1) no 24-month-old moose ($n = 38$) were pregnant, 2) only 29% of 76 36-month-old moose and 66% of 58 48-month-old moose were observed parturient, and 3) no moose observed less than 60 months old produced twins. We documented a minimum 20% decline in production with a 3.2-fold increase in density since 1978. However, the substantial increase in moose numbers has allowed far greater sustainable yields than would have been possible at the lower density.

Transrectal ultrasonography and PSPB analyses produced identical results in 1996, the only year in which both results are available. However, daily observations during the calving seasons indicate lower actual productivity in the population and less variability than indicated using ultrasound or PSPB. We use observed parturition rates as the best indicators of production in the population because they are most meaningful to the population and

because of the likelihood of neonatal or intrauterine mortality in this high-density population.

Management staff have flown spring twinning rate transect surveys in central portions of the Tanana Flats for several decades without the use of radiocollared moose. Because these surveys more readily sampled moose from all age classes each year, these surveys more accurately estimated twinning rates in the population compared with our sampling of radiocollared moose. To further investigate the accuracy of twinning rate transect surveys, we tested whether differences in twinning rates could be observed with a helicopter versus a fixed-wing aircraft and found no significant differences.

Weighing short yearling moose appears to be a particularly useful and relatively inexpensive tool for evaluating moose population condition. For example, we noted substantial differences between weights in the adjacent Denali and Unit 20A populations. We also noted significant differences in weights between subpopulations within the study area. Short yearlings weighed in the Tanana Flats have weighed significantly less (about 17 kg less on average) than those in the Alaska Range foothills every year. Although virtually all calves are born in the Tanana Flats, calves that move to the Alaska Range foothills in summer or autumn must have an improved energy balance relative to those remaining in the Tanana Flats. Because of the reduced moose body weights in the Tanana Flats, we have assigned the Tanana Flats a higher priority for improving moose habitat compared to the Alaska Range foothills.

We expected birthweights to provide a relatively sensitive index to winter and spring maternal and range condition and that elevated birthweights would occur among the Alaska Range foothills subpopulation, in part because short yearlings weighed significantly more in the Alaska Range foothills. However, birthweights may provide only a nonsensitive index to winter and spring conditions. For example, we found no significant differences in newborn singleton or twin birthweights with regard to dam collaring location or capture year. As expected, newborn weights in Unit 20A are relatively low compared with those from the Yukon Flats, where moose density is 85% lower and the observed twinning rate (63%) indicates a high nutritional status during ovulation. Our unique finding of a significant difference in birthweights between singleton male and female moose calves may be an indication of the relatively poor nutritional status of moose in Unit 20A.

Depth of rump fat is an index to the condition of individual moose, and potentially an index to relative condition of a moose population. We initially hoped to contrast annual differences in rumpfat depths among young moose, e.g., moose in the 10- and 22-month-old cohorts, to provide a tool to evaluate annual differences in moose condition. However, we detected no rump fat among moose in these cohorts. This lack of rump fat apparently is a sign of malnutrition at the current high densities, given that some 22-month-old moose have fat in Denali National Park.

Because short yearling bodyweights differed between the Tanana Flats and the foothills we expected to find significant differences in adult rumpfat depths from these 2 subpopulations. However, we found no significant differences. We conclude that adult

rumpfat depths are less sensitive indices of nutrient regime compared to short yearling bodyweights, presumably because rumpfat depths were gathered from a sample of adults of all ages and reproductive histories. Perhaps with a greater sample size, rumpfat depths could be used to detect significant differences in nutrient regimes in these subpopulations.

We conclude that rumpfat depth is a more expensive and, at times, less sensitive index to nutrient regime in moose compared to twinning rates and weights of short yearlings. We did find significant relationships between March rumpfat depths and reproductive status of females, but reproductive indices are much less expensive to collect than fat depths.

Mean maximum depth of rump fat was significantly greater among pregnant versus nonpregnant adult cow moose. Mean maximum depth of rump fat was also significantly greater for moose observed parturient versus those never observed with a calf and for dams giving birth to twins versus those with singletons. We also found that the fattest dams produced on average the heaviest calves. Further, as expected, regression indicated a negative relationship existed between calving date and maximum March rumpfat depth.

With the blood obtained from adult female moose in 1996 and 1997, we attempted to identify potential relationships between 22 serum constituents and rumpfat depth using multiple regression models. We conclude, at this time, that standard serum constituents are not useful indicators of rumpfat reserves in moose. In addition, the acute phase protein haptoglobin was not helpful in distinguishing stressed from nonstressed individuals.

OBJECTIVE 3: Determine causes and respective rates of mortality among radiocollared moose of various age classes in Unit 20A.

Adult natural mortality varied from 7–21% annually during this study. In contrast, almost no mortality was observed between the ages of 24 and 48 months.

Yearling mortality rates averaged 13% during 1997–1998, 33% during 1998–1999, 17% in 1999–2000, and 18% in 2000–2001.

Wolf predation was the major cause of death among adult and yearling moose. In 23 cases where we were able to investigate the cause of death of random radiocollared adults, wolves killed 14 (61%), grizzly bears killed 4 (17%), and 5 (22%) died from factors other than predation. Of 35 yearlings (12–24 months old) that died, wolves killed 24 (69%), bears killed 8 (23%), and 3 (9%) died from other factors.

Hunters took a nominal harvest of cows in the study area during September 1996, 1997, 1998, and 2000. These were the first legal cow harvests since 1974. Annual cow harvests during these years in Unit 20A have averaged 66 cows.

The 1996 and 1997 radiocollared newborn calves experienced the highest annual survival rates (52–56%) among the 7 Alaska-Yukon moose calf telemetry studies conducted to date. High calf survival undoubtedly contributes to the reduced reproductive performance of this population.

Predation was by far the major proximate cause of death in this and all previous moose calf mortality studies. Wolves killed more calves than both bear species in this study, while grizzly bears and black bears killed about equal proportions of calves. In previous moose calf mortality studies, either black or grizzly bears were clearly the major predator. In addition to mortality detected using radiocollared calves, mortality prior to birth or neonatal mortality during the first 24 hours after birth apparently occurred in 7 (17%) of 42 pregnancies in 1996 and 3 (13%) of 23 pregnancies in 1997.

We studied the relationship between calf survival and birthweight, birth date, and sex for calves born during 1996 and 1997. These data indicate that all calves are equally vulnerable to mortality factors common to this first month of life. However, modeling indicated increased mortality of lightweight calves at older age classes. In addition, preliminary analysis of the data supports the hypothesis that no relationship exists between dam condition (age, fat reserves, and collaring location) and mortality of their calves within the range of values observed.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB 2: Estimate reproductive and condition parameters of moose.

During this reporting period we captured 40 female yearling moose, primarily using a R-22 helicopter; 20 individuals were captured in the Tanana Flats and 20 in the Alaska Range foothills. This is the fifth cohort we have sampled in this manner. Captured moose were weighed to assess condition and then radiocollared. Telemetry flights will provide data on reproductive performance and mortality of the 2000 cohort.

Approximately 30 fixed-wing radiotracking flights were flown between mid-May and mid-June 2001 to observe parturition and twinning rates of radiocollared moose greater than 2 years old.

JOB 3: Assess causes and rate of mortality of adult moose.

To assess causes and rates of mortality of moose within the study area, all radiocollared moose were tracked monthly with fixed-wing aircraft during this reporting period. In addition, a helicopter (R-22 or R-44) was deployed to recover collars and investigate mortality sites of 17 collared moose.

JOB 4: Report writing and integration of results into ongoing management reports.

During this reporting period we submitted the 1 July 1999–30 June 2000 Research Progress Report for this study (1.51). We also submitted the 2001, 5-year Wildlife Research Study Plan for continuation of this project. In addition, data collected from the project is used in Unit 20A moose management reports and advisory committee meetings.

III. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

No additional Federal Aid funded work was accomplished during this period.

IV. RECOMMENDATIONS FOR THIS PROJECT

We hope to eventually maintain moose at moderate to high densities without repeating predator control programs that apparently helped moose increase to high densities in Unit 20A. We will continue to monitor the population with the techniques we currently have in place. In addition, we hope to monitor the response of the population to greater environmental stress such as severe winters. Currently we have the right tools in place to do so.

Further, we are completing fieldwork on browse use and availability as part of a graduate student project conducted by CT Seaton. These quantitative browse studies will 1) provide a baseline of browse information for comparisons with other areas, 2) potentially help explain why yearling moose residing in the Tanana Flats consistently weigh less than those migrating to the foothills, and 3) assist in prioritizing habitat management activities.

Finally, within the next few years we hope to work with an additional graduate student whose project will focus primarily on moose movements, dispersal, and birth site fidelity within the Unit 20A study area. Moose movements at the current high density will be contrasted with movements described in the mid-1970s, when moose density was low.

V. PUBLICATIONS

Relationships between blood-serum variables and depth of rump fat in Alaskan moose
KEECH MA, TR STEPHENSON, RT BOWYER, V VAN BALLEMBERGHE, AND JM VER HOEF.
1998. *Alces* 34:173–179.

Abstract: We studied the relationship between maximum depth of rump fat determined from ultrasound measurements and 22 blood values for Alaskan moose (*Alces alces gigas*) by sampling 38 pregnant, adult females. Moose were immobilized, and blood was drawn simultaneously with the determination of depth of rump fat during 1–4 March 1996. Multiple-regression models were used to detect relationships between blood-serum variables and depth of fat. Four of 22 blood-serum variables were removed to control for multicollinearity. Remaining variables were regressed against induction time (\bar{x} = 6.1 min, SD = 4.4 min). Glucose, sodium, and blood urea nitrogen were correlated with induction time (R^2 = 0.27, P = 0.010) and likely represented a response to handling; these blood values also were removed from the final regression model. Mallow's C_p statistic indicated the most appropriate regression model included only 2 variables. Creatinine (\bar{x} = 2.08 mg/dl, SD = 0.26 mg/dl) and aspartate aminotransferase (AST) (\bar{x} = 79.10 U/l, SD = 13.61 U/l) met all necessary assumptions and explained a portion of the variability observed in fat depth (\bar{x} = 1.5 cm, SD = 1.0 cm). Thus, our final model was: maximum depth of rump fat = 0.28 + 1.68 (creatinine) – 0.03 (AST). This model was significant (P = 0.0002) and accounted for 33.7% (R^2) of variability observed in fat depth. Partial regression coefficients for creatinine and AST were 0.222 (P = 0.0025) and 0.150 (P = 0.006), respectively, and indicated that creatinine was slightly more influential than AST in the model. These blood variables may provide insights into the predicted condition of moose and the response of moose to environmental conditions. A model using blood variables thought to be indicators of physical condition (protein, phosphorous, and calcium) did not explain significant variation in maximum depth of rump fat.

Effects of birth weight on growth of young moose: Do low-weight neonates compensate?

KEECH MA, RD BOERTJE, RT BOWYER, AND BW DALE. 1999. *Alces* 35:51–57.

Abstract: We studied the relation between birth weight and 3 measurements of body size in 10 female Alaskan moose (*Alces alces gigas*) at 10 months of age in a population where density was high (1.3 moose/km²), compared with other areas of interior Alaska. Our study area was located in interior Alaska, USA, between the Tanana River and the Alaska Range, directly south of Fairbanks. We captured newborn (<5 days old) moose from helicopters, weighed them, and then affixed radio collars during 14 May–3 June 1997. These same moose were immobilized with a dart-gun fired from a helicopter, weighed, and measured during 13–16 March 1998. We used regression analyses to investigate the relationships between weight at birth and weight, metatarsus length, and total body length for recaptured individuals at 10 months of age. Positive linear relationships existed between each measure of size at 10 months and weight at birth, and were highly significant ($P < 0.02$). Further, birth weight explained significant variability in each of those 3 measurements ($r^2 = 0.63, 0.64, 0.53$, respectively). Our results support the hypothesis that neonates with lower weights at birth in this population did not exhibit compensatory growth and remained among the smallest individuals in their cohort, at least during their first 10 months of life.

Life-history consequences of maternal condition in Alaskan moose

KEECH MA, RT BOWYER, JM VER HOEF, RD BOERTJE, BW DALE, AND TR STEPHENSON. 2000. *Journal of Wildlife Management* 62:450–462.

Abstract: We studied life-history characteristics of Alaskan moose (*Alces alces gigas*) including the effects of maternal condition of adult females (>33 months old) on survival and physical condition of young during their first year-of-life. We also examined the relation between maternal condition and reproductive parameters of individual adult moose, and tested for effects of those parameters on timing and synchrony of parturition. We radiotracked adult females captured in both March 1996 and 1997 throughout the year with intensive monitoring occurring during spring and early summer. That procedure enabled us to capture the offspring of females we monitored and record other variables related to reproductive success. Females with greater rump fat thickness had higher rates of pregnancy, gave birth to more twins, and produced young with higher birth masses than did females with less rump fat. Time-to-death for individual young increased as birth mass increased and decreased as birth date and litter size increased; those birth variables, however, did not act upon time-to-death independently. Our results indicated maternal condition influenced subsequent variables associated with birth, which ultimately affected future survival of offspring. Further, timing of reproduction varied between the 2 years, with births occurring earlier but not more synchronously in 1996 than in 1997. Time of parturition occurred earlier for individual females with the thickest rump fat. That outcome indicated that timing of parturition was the result of environmental factors acting on females prior to giving birth rather than effects of attempting to avoid predation.

VI. FEDERAL AID TOTAL PROJECT COSTS FOR THIS SEGMENT PERIOD

Total Federal Aid project costs during this period were \$37,300, including all personnel and operating costs.

VII. PREPARED BY:

Mark A Keech
Wildlife Biologist II

Rodney D Boertje
Wildlife Biologist III

Donald D Young
Wildlife Biologist III

SUBMITTED BY:

Patrick Valkenburg
Research Coordinator

Laura A McCarthy
Publications Technician II

APPROVED BY:

Steven R Peterson, Senior Staff Biologist
Division of Wildlife Conservation

Wayne L Regelin, Director
Division of Wildlife Conservation

APPROVAL DATE: _____